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# HOT ROOM CALLUSING

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Nursery of Bench Grafts.

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## HOT ROOM CALLUSING.

1. *Defects of Ordinary Methods.\** In the production of grafted resistant vines, it is necessary, after the cuttings are grafted, to *callus* them before planting in the nursery. This callusing consists in the formation, on the cut surfaces of stock and scion, of healing tissue by which the union is brought about. For this process certain conditions of moisture and temperature are required. These conditions are obtained by stratifying the grafts in "callusing beds" of sand as described in Bulletin 180.



FIG. 1.—Grafting house, south front, showing sand callusing beds.

The sand callusing bed has many defects and inconveniences. It has too much dependence on weather conditions. If the weather is cold the cuttings remain dormant so long that they may rot or dry out before callus forms. If the weather is warm they may callus too soon, and, before the nursery is in condition for planting, the buds and roots may have grown so much that many are killed or injured in removing to the ground. Even with the most favorable weather, the callusing is completed at various times owing to the grafting being carried on for several weeks or months, and it requires constant care and vigilance

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\*For a discussion of the general practice of resistant vine grafting and callusing the reader is referred to Bulletin 180, "Resistant Vineyards."

to catch the grafts at exactly the best stage for planting. It is difficult or impossible to construct a sand bed in which the condition of temperature and moisture are uniform in all parts. In one part of the bed some of the grafts will have progressed too far, while, in another, grafts of the same kind made at the same time will have hardly started to callus.

The period of callusing will vary, under identical conditions, with the variety of stock and scion. Where several varieties are being grafted some must be planted too soon and some too late, unless separate beds are used for each combination, which is troublesome and impracticable. All these irregularities not only diminish the percentage of first class vines produced, but the special care needed greatly increases the labor and cost. The handling of grafts in a sand bed makes it necessary that stock and scion should be very firmly held together. This necessitates tying the grafts at a cost almost equal to the actual grafting, and also the removal of the tying material in the nursery which is both troublesome and expensive.

The method of stratifying in boxes of moss and callusing in a hot room overcomes many of these difficulties, and has therefore been adopted by all the large producers of grafted vines.

2. *Methods of Grafting.* When stratified in moss, the grafts are not subjected to any rough handling and it is therefore unnecessary to tie them. The ordinary "whip" graft, however, is unsuited to this purpose because the cut surfaces will not remain in contact unless they are tied. Two forms have been found suitable, *i. e.*, the "Wire graft," and a "Modified whip graft." The former is fully described in Bulletin 180. It is peculiarly suited to beginners, owing to the ease with which it can be made without practice. It would undoubtedly be more used by nurserymen but for an unfounded prejudice that the wire is injurious to the vine. To make this graft, stock and scion of the same diameter are cut at an angle of about  $45^{\circ}$  and kept in contact by means of a piece of No. 17 gauge galvanized iron wire, about 2 inches long, inserted in the pith. Stock and scion should be pressed together firmly and it is usually best to use two pieces of wire.

The modified whip graft differs from the ordinary form principally in the angle of the bevel and the position of the tongue. The bevel is made nearly as steep as for the wire graft. The length of the cut is about 1.75 times the diameter of the cutting, which corresponds to an angle of about  $35^{\circ}$ . In the ordinary whip graft, the cut is made from 2.5 to 3.5 times the diameter of the cutting. The shorter bevel does away with the tendency of the points to draw apart. The tongue commences much nearer the top of the cut in this form and reaches nearly to the bottom. It is made by a sliding motion of the knife from left to

right or in the reverse direction. In withdrawing the knife the point of the tongue is bent out by a twist of the knife in order to facilitate the putting together of stock and scion. The tongue is made by cutting slightly across the grain, as in ordinary whip graft, but is slightly thicker than in the latter case.

When properly made, grafts of this kind hold together very firmly and resist lateral and longitudinal displacement sufficiently for handling. Figure 2 shows the two methods described in comparison with the ordinary whip graft.

3. *Graft Trays.* While properly made grafts hold together with considerable firmness, the less and the more carefully they are handled

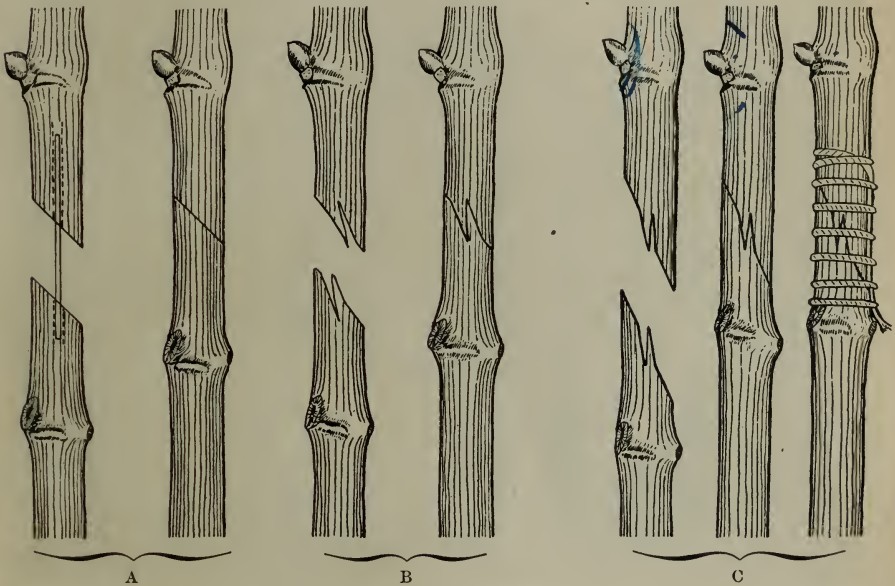


FIG. 2.—A, Wire graft; B, Modified whip graft; C, Ordinary whip graft.

the fewer will fail. With this object, graft trays or stands are useful. Each grafter is usually furnished with a shallow tray in which he places the grafts as he makes them and in which they are carried to the callusing boxes. Stands like that illustrated in Fig. 3 are better. This stand consists of a piece of  $\frac{1}{2}$ -inch board 16 inches by  $9\frac{1}{2}$  inches, furnished with a  $3\frac{1}{2}$ -inch cleat at the back to hold the grafts, a  $1\frac{1}{2}$ -inch cleat at the front to protect the unions, and two legs to keep the stand at a convenient angle. Such a stand will hold from fifty to one hundred grafts and protect them from injury when carried and handled with a minimum of labor and care.

4. *Callusing Boxes.* The sizes of the boxes may vary, but for ease of handling there is a practical maximum. When grafting is practiced

on a large scale, boxes 40 inches in length and 20 inches in width are generally used. The depth varies according to the length of the grafts. It should be at least from 8 to 10 inches longer than the grafts, or for Californian conditions about 22 to 24 inches in all. On a small scale it is better to have smaller boxes. Their handling and the separation of the varieties are very much facilitated. For two years boxes like those represented in Fig. 4 have been used successfully at the University Farm, at Davis. Such boxes measure 25 inches in depth, 16 inches in width, 19½ inches in length, and will hold from 450 to 500 grafts, according to the thickness of the cuttings. In order to facilitate the placing of the grafts in the boxes and their removal, one of the shorter sides



FIG. 3.—Graft stand.

should be attached by means of screws, or by a slit, so as to be easily removable. The bottoms of the boxes must be perforated with several rows of small holes, which allow the excess of water to drain off after dipping as described later. The tops of the boxes remain open.

5. *Callusing Materials.* The material used for filling the boxes must present the following characteristics:

1. High retentive power for water.
2. Ease of aeration.
3. Freedom from molds.
4. Lightness.
5. Cheapness.

The first three conditions are necessary for the proper formation and

development of healing tissue. The fourth facilitates the handling of the boxes.

Among the numerous callusing materials tried with this method a few fully answer the above requirements. They are: seaweed, moss and sawdust, with each of which charcoal is added for its antiseptic properties. Experience has shown that a mixture of two thirds moss and one third charcoal, and one of two thirds sawdust and one third



FIG. 4.—Callusing box and dipping vat.

charcoal give satisfactory results. The first of these mixtures is used as a bottom and lateral covering, the other as a filling and a top covering. The charcoal must be sifted and the biggest particles must not be larger than peas. These materials are mixed beforehand to be ready when needed. The moss is first soaked, drained and spread on a clean floor, charcoal is then added. Two or three alternating layers of moss and charcoal are put together and the mass is uniformly mixed. If the mixture appears too dry, water is added by sprinkling. For the saw-

dust-charcoal mixture it is better to mix the dry components and add water afterwards.

6. *Filling the Boxes.* With the above described mixtures at hand, a callusing box is placed with the short side down and the removable side open and on top. The other sides of the box and part of the bottom receive a uniform hand-pressed layer of moss and charcoal two inches thick and the grafts are laid horizontally, stocks toward the bottom and scions exactly at the same distance from the normal top of the box. After two or three layers of grafts have been placed in this way, a thin layer of the sawdust-charcoal mixture is sprinkled over them. The coating of moss-charcoal is now carried up the long sides and bottom a few inches higher and another layer of grafts added. When, in this manner, the box is filled up to within two inches, the remaining space is filled with the moss-charcoal mixture. The removable side is then fixed in place and the box set upright. The scions are just covered with the sawdust-charcoal mixture and the box dipped in water. After a few moments immersion it is put aside to drain.

For this purpose a dipping tank or vat is needed. This should be a little larger than the callusing boxes used, conveniently placed and with some means of filling it with warm water. The dipping vat used at Davis is shown in Fig. 4. It is made of concrete and supplied with a steam pipe by means of which the water can be raised to the desired temperature. It is filled by means of a hose and emptied by a tap at the bottom communicating with a drain.

After the excess of water has drained out of the box, if the mixture has sunk, its original level is reestablished by adding more of the sawdust-charcoal. A layer 2 inches thick of excelsior, softened by soaking in water, is then put directly on top of the scions. On this, a piece of sacking, exactly fitting the top of the box is placed and in turn received a two to three inch layer of the sawdust-charcoal mixture. The excelsior allows the development of the buds and proper aeration. The piece of sacking facilitates watching the progress of callusing and any necessary changes of the covering.

7. *Hot Room.* The hot room must be of convenient size and shape to facilitate handling the boxes. The boxes may be placed in two or three superposed layers on shelves or trestles. A space of several inches should be left between them and the wall and between the sides of adjacent boxes.

Windows or other apertures should be so spaced as to insure even and complete ventilation. Light is unnecessary and the direct rays of the sun should be avoided.

Any heating system which will maintain an even temperature may be used. A small coal oil stove is sufficient for a small room. Hot water

or steam heating appliances are preferable for large scale operations. With well insulated walls in ordinary weather the heat can be kept sufficiently constant without a fire at night.

If there is any considerable difference of temperature in various positions, as when the boxes are in superposed layers, it is necessary to change the position of the boxes occasionally in order to insure even callusing.

8. *Temperature.* Heat is a necessary factor in the formation of healing tissue. The temperature of the hot room, as said before, must be kept regular. The heating of the room should be started before the boxes are placed there until the desired temperature becomes uniform. A well equipped callusing room should possess a maximum and minimum thermometer, mounted on a piece of board fixed to the wall at five feet from the ground and on the opposite wall an ordinary thermometer. At what temperature the room should be kept depends on the result desired. To determine this it is necessary to know the characteristics of a well-callused graft. Such a graft shows healing tissue formed all around the cut surfaces and in sufficient quantity to cause them to unite. It should, after a certain time, be strong enough to withstand a pull of several pounds without breaking. The scion buds should be dormant or only slightly sprouted. This can be obtained by keeping the temperature of the room between 70° and 80° F. At these temperatures it will require between twenty and fifteen days to produce a good union of stock and scion. At 86° F., the formation of callus is much quicker and can be obtained in about ten days, but the callus is of a softer texture and has a tendency to grow too large. With certain precautions, this temperature can be used when grafting is done very late in the season.

When grafting is started early in the season, the callusing is done at about 77° and in two different ways. In one, the grafts are callused immediately and then kept in a cool place until planted, in the other, the grafts are kept in a cool room at a temperature of about 60° F., and callusing in the hot room commenced about 2 weeks before the time for planting. The former method is most convenient.

9. *Moisture.* Another important factor in the formation of healing tissue is moisture. The best conditions in this respect occur when there is sufficient moisture present to prevent all drying of the cuttings without forcing root formation. In a sand bed, the optimum amount of water will vary from 2½ to 7½ per cent of the weight of the sand. The purer and coarser the sand, the less water needed. The finer the sand and the more earthy or clayey material it contains, the larger the amount of water it will hold which is unavailable for the grafts.

The degree of humidity is much more easily controlled in callusing

boxes than in sand beds. When examination shows that there is too much moisture at the level of the unions the cover of sawdust, sacking and excelsior is removed and after aeration replaced with drier material. Excess of moisture is evidenced by slowness or absence of callus formation and by growth of mold. The cover is prevented from becoming too dry by occasional sprinklings with water of the temperature of the room.

With a little practice it is easy to determine the most favorable degree of humidity. The principal danger is the presence of too much water. Providing the excelsior covering feels moist to the hand, there is no danger of the unions suffering from dryness.

After about ten days in the hot room at a temperature of 77° F., the



FIG. 5.—Cutting shed used for hardening callused grafts.

boxes are dipped in warm water (77°–80° F.). The boxes should be carefully lowered into the dipping vat so that the water gradually enters the holes in the bottom and fills the box nearly to the level of the unions, which it should not reach. The boxes are then removed, allowed to drain and replaced in the hot room. The dipping equalizes the moisture, stimulates the vital processes and thoroughly aerates by renewing the air. One dipping during the time the boxes stay in the hot room is usually sufficient.

10. *Aeration.* The presence of oxygen is absolutely necessary for the formation of healing tissue. Grafts tied with raffia in such a way that the air is excluded from the cut surfaces do not callus well; when tin foil is used in a similar way they do not callus at all. When, by an

excess of moisture and a high temperature, a fungus film forms over the unions, the air is excluded and callus fails to form.

The hot room should be well ventilated and the box covers should be arranged to give all the aeration needed.

11. *Removal from Hot Room.* When the desired amount of callus has been formed and the unions are complete all around, the boxes are removed from the hot room. At this stage the best grafts should show indications of root formations and a slight swelling of the buds. Others may have formed shoots of half an inch or so and rootlets of the same length. This condition is reached with most varieties in about fourteen days at a temperature of 77° F.

On removal, the boxes are dipped again in water of about 75° F. or



FIG. 6.—Grafting house, north front.

just a little below the temperature at which they have been kept. Cold water would be injurious to the delicate growing tissues. After draining, the boxes are removed to a cool place for hardening.

12. *Hardening.* Though the unions are nearly complete when removed from the hot room the grafts cannot safely be planted immediately. The callus is too soft and delicate to be exposed to the cold and varying temperature of the soil without suffering. The change must be gradual to give time for the hardening of the new tissues. The boxes are therefore stored in a room where the temperature is regular and a few degrees (10° or 15°) cooler than that of the hot room. Here the grafts unite more thoroughly and gradually become accustomed to a lower temperature. After a week in this room, they should be placed

outside in a shed, where they will gradually reach the mean outside temperature. In this shed they should be protected from the direct rays of the sun, from rain and from drying winds. The shed shown in Fig. 5 has been found suitable at the University Farm. They may be left in this shed for several weeks if necessary, but must be carefully watched to prevent drying out.

Before the boxes are taken to the nursery, they should be given a third dipping, this time in ordinary cold water. This will protect them from drying while being planted.

13. *Planting.* The callused grafts should be planted as soon as the nursery soil is in good condition and the temperature of soil and air are favorable to growth. The best time is at or a little before the start of vegetation in the vineyard. A great advantage of this method is that callusing is started immediately after making the grafts, while the cuts are still fresh and before the tissues have suffered from drying or too much moisture. An equal advantage is that all the grafts at whatever time they are callused may be planted at the same time. After callusing they are simply kept dormant in the cool shed until weather and soil conditions are favorable for planting.

When everything is ready the boxes are removed to the nursery, the removable side taken off and the grafts carefully transferred to shallow boxes or trays. If any of the grafts have formed long shoots or roots, these should be trimmed off as they cannot be saved and it is better to remove them before planting. If the weather is hot or dry the trays of grafts should be covered with a wet sack until they are planted.

The nursery work is identical with that used in the ordinary methods described in Bulletin 180 with the exception that there is no tying material to remove.